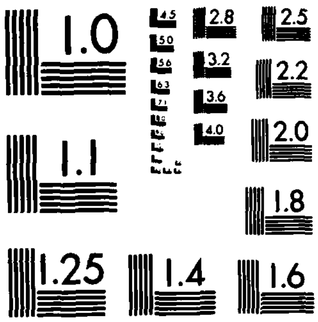
AD-A144 906 REQUIREMENTS AND SPECIFICATIONS FOR CARTOGRAPHIC VIDEO DISCS(U) ARMY ENGINEER TOPOGRAPHIC LABS FORT BELVOIR VA D J COSTANZO JUN 84 ETL-R-066 1/1

UNCLASSIFIED F/G 8/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLA

SECURITY CLASSIFICA

REP

AD-A144 906

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER R-066	NO. 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Requirements and Specifications for Cartographic Video Discs	5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Daniel J. Costanzo	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Engineer Topographic Laboratories Fort Belvoir, VA 22060-5546	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS SEE 9	12. REPORT DATE June 1984 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Video discs
Cartographic
Microcomputers
Software
Requirements and Specifications

1984

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Video discs can store large quantities of analog (paper, film, and video tape) and digital cartographic products on a compact, nonvolatile medium. These discs can be interfaced with microcomputers to provide compact and portable systems for accessing this cartographic information. Such interactive video disc systems could be used for terrain analysis, navigation, map use training, and command and control.

DTIC FILE COPY

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

84 08 22 038

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

COSTANZO

TITLE: Requirements and Specifications for Cartographic Video Discs

DANIEL J. COSTANZO
U.S. Army Engineer Topographic Laboratories
Fort Belvoir, Virginia 22060

ABSTRACT:

Video discs can store large quantities of analog (paper, film, and video tape) and digital cartographic products on a compact, nonvolatile medium. These discs can be interfaced with microcomputers to provide compact and portable systems for accessing this cartographic information. Such interactive video disc systems could be used for terrain analysis, navigation, map use training, and command and control.

Video discs used for cartographic data storage should be treated as mapping products in the same way as analog and digital cartographic products. Thus, there is a need to develop requirements and specifications to design and to produce these video discs. Particular attention is needed in the following seven areas: planning, gathering source materials, filming, transferring film to video tape, mastering, replicating, and developing software.

The U.S. Army Engineer Topographic Laboratories (ETL) recently began research into requirements and specifications for these video discs. ETL is developing experimental cartographic video discs, investigating video map graphic design, and studying new technologies for video discs.

BIOGRAPHY:

PRESENT ASSIGNMENT: Physical Scientist, U.S. Army Engineer Topographic Laboratories.

PAST EXPERIENCE: Cartographic Technician, U.S. Department of Agriculture, 1977-1980.

DTIC COPY INSPECTED 2

A1

REQUIREMENTS AND SPECIFICATIONS FOR CARTOGRAPHIC VIDEO DISCS

DANIEL J. COSTANZO
U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES
AUTOMATED CARTOGRAPHY BRANCH
FORT BELVOIR, VIRGINIA 22060

INTRODUCTION

Storage and rapid retrieval of cartographic data are major problems for the military user. Often source materials end up in disorganized piles, stuffed into map file cabinets, and crammed into desk drawers. This problem is compounded by the fact that modern cartographic information comes in a variety of formats ranging from digital data tapes, to video tapes, movie film, paper photographic prints, paper maps, charts, and documents. Each of these media has its own space and enviromental requirements for storage and use. The problems involved in dealing with this wealth of diverse data can become both frustrating, expensive, and in some cases life threatening on the battlefield.

Recently, laser video disc technology was applied to this problem of storing and displaying cartographic data. The video disc offers the advantage of being a compact medium for storing information. A standard sized, rigid plastic video disc is about the size and shape of a phonograph record. It can store up to 54,000 frames of National Television System Committee (NTSC) standard television pictures per side. This is analogous to a 35-mm slide tray with 54,000 individual slides. Video disc frames are accessed via a low-powered laser beam, reflecting off microscopic pit and groove patterns on the disc surface. Unlike video tape, any single video disc frame can be randomly accessed by the laser in three seconds or less, and can be held on the television screen indefinitely. Unlike magnetic tape or magnetic disk, the video disc is impervious to magnetic disturbances.

Anything capable of being recorded onto video tape may be stored onto video disc. This includes paper maps, documents, and diagrams; photographs either on film or on paper; movie film; and video tape itself. Digital data can also be placed onto a video disc by first converting the data into an analog video signal and then recording it onto video tape.

Software can be developed to interface video discs with microcomputers (Figure 1). This software enables a user to scan through the cartographic data base, to bring up registered scenes of various kinds of maps or imagery, to process the video signal to enhance important map and image features, to reference the video maps to geographic coordinates, and to place computer generated graphics over video maps and images. Also, three-dimensional terrain views could be generated using digital data stored on the video disc.

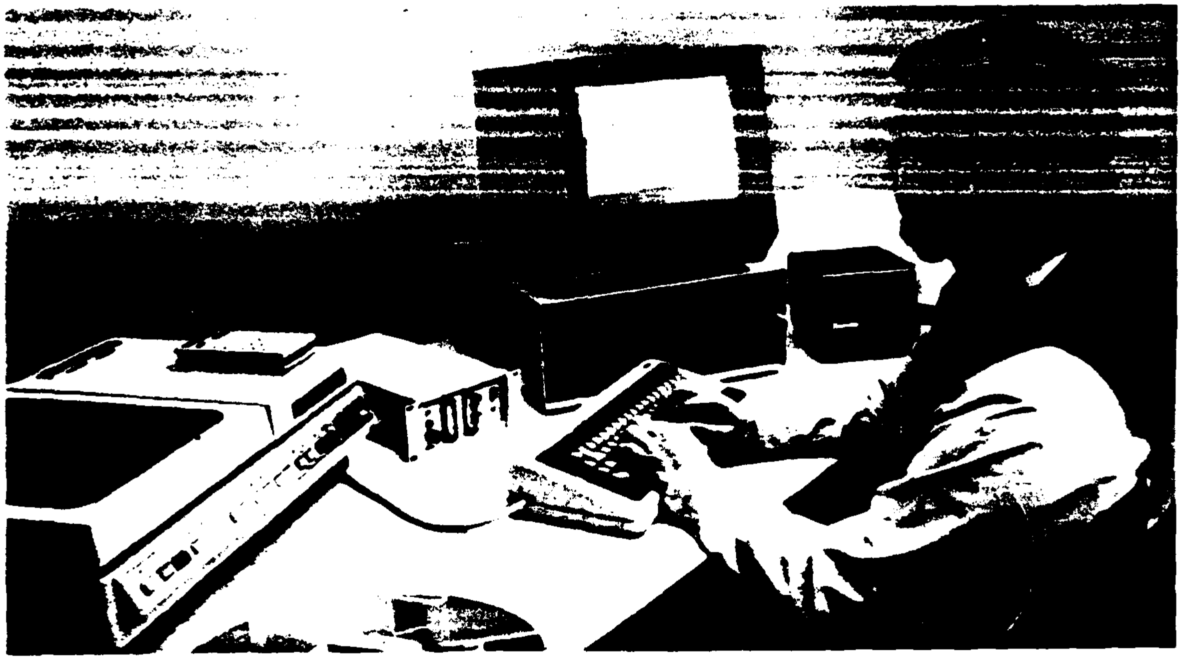


Figure 1 - The Map Video Processing (MVP) System at the U.S. Army Engineer Topographic Laboratories.

Video discs can be used to create versatile and rugged geographic information systems. Such interactive video disc systems could find uses as command and control devices, cockpit and vehicle navigation aids, simulators, cartographic product catalogs, and video atlases. By utilizing the small size and portability of the video disc-microcomputer combination, such systems offer more secure stations for battlefield analysis of cartographic data.

There are, however, several disadvantages to present video disc technology. A major factor is the limiting resolution of standard television monitors. The NTSC video signal fixes horizontal television resolution to only 525 slightly slanted horizontal lines. However, only 480 of these lines are visible on the screen. Standard television also has 325 vertical resolution lines. However, this vertical resolution can vary from 730 lines for high quality monitors, down to approximately 280 lines for poor quality monitors. Screen resolution also depends on the type, size, and quality of the video signal being fed into the monitor. Such low monitor resolution causes problems when viewing detailed map and image products.

Video discs also have the disadvantage of being unalterable. To make a video disc, a video disc master is created from a master video tape. Plastic copies of the disc are then stamped out in much the same way as phonograph records. Once created, these plastic discs are unalterable. More expensive Direct-Read-After-Write (DRAW) video discs are available, but these simply record new video pictures onto unused portions of the DRAW disc.

Finally, there are no established requirements and specifications for putting cartographic data onto video discs. Currently, no two video discs for a given geographic area follow exactly the same format. This creates problems when video discs need to be viewed manually or interfaced with microcomputers. Such important features as ease of access, clarity, and geometric stability of the data on the discs suffer from this absence of requirements and specifications.

A cartographic video disc is a mapping product, just like the paper map or digital data base. Thus, it should conform to rigid requirements and specifications, just like other cartographic products. This paper describes important requirements and specifications for storing and accessing analog cartographic products on video disc.

Figure 2 illustrates the present design and production process for cartographic video discs. The process can be generalized into the following seven steps: planning, gathering source materials, filming, transferring film to video tape, mastering, replicating, and developing software. Requirements and specifications for each phase of the design and production process are discussed in the following sections of this paper.

PLANNING

The amount of care and attention to detail going into the planning stage determines the usefulness of the final video disc product. Its 54,000 frames must be designed so that someone manually viewing the disc should be able to follow the disc's organization. This planning should minimize search time when randomly accessing frames. "Story boards," which are diagrams illustrating the design of the disc, are a great aid to the planning process. Small scale maps covering large areas should precede larger scale maps so that pacing through the disc shows more detailed views of a geographic area. Maps, aerial photographs, and satellite images for the same areas should be grouped together on the disc.

Different cartographic products must be separated on the disc by neatly lettered "slates." These would appear on the screen and describe important information about the map or image product. And finally, a clearly, typewritten index to the disc must be created and followed. It must list, in order, the materials on the disc, along with their corresponding frame numbers.

Consideration must also be given to the type and quality of hardware to be interfaced with the video disc. This hardware must be integrated into a working system. A truly interactive video disc system should consist of:

* One or more video disc players
* 8-bit or 16-bit microcomputer
* Two floppy disk drives
* One hard disk drive
* Three or more frame buffers
* One or more television monitors
* Light pen
* Joystick and touch panel
* Digitizing tablet
* Facsimile image printer and line printer

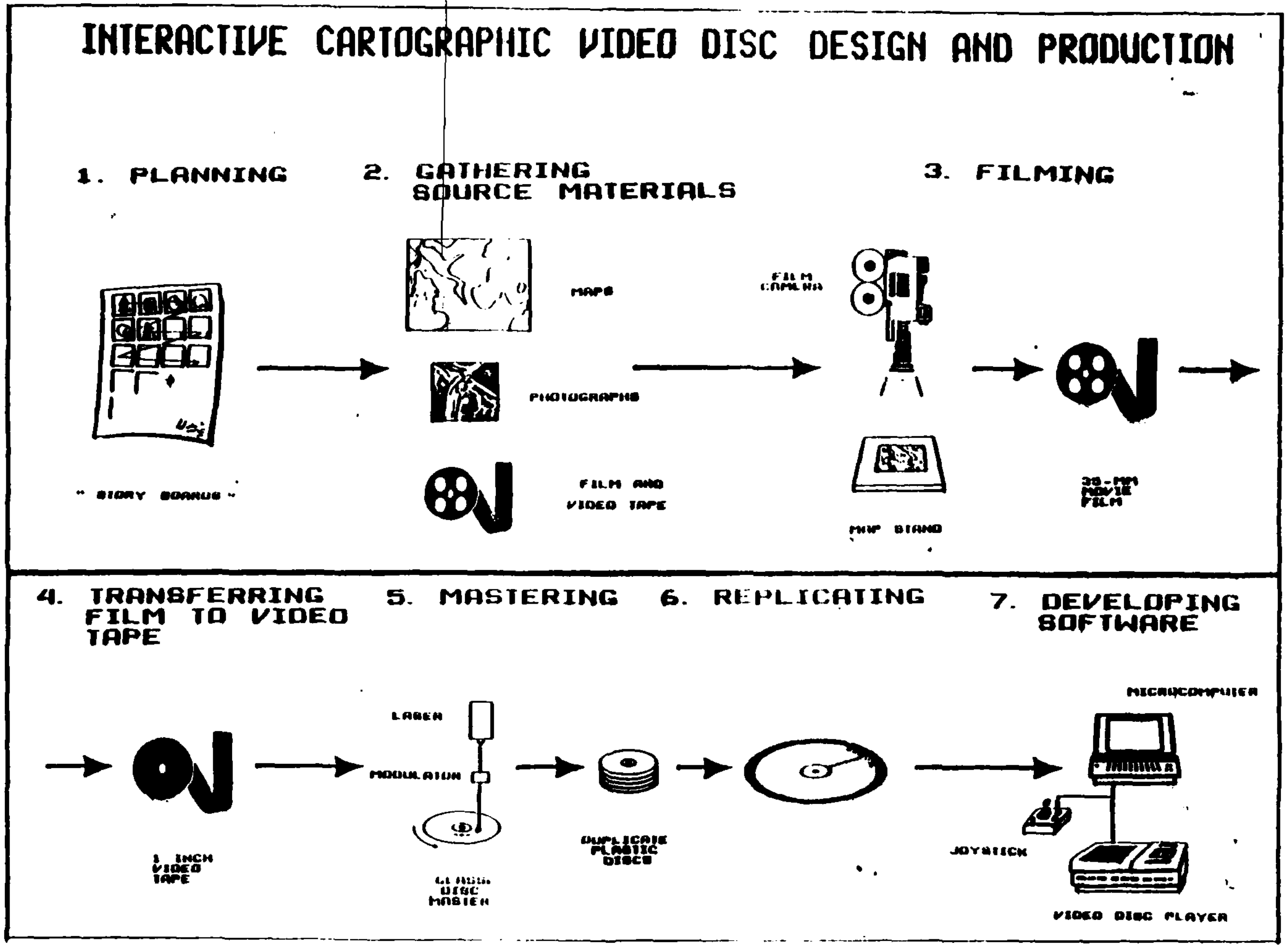


Figure 2 - Interactive cartographic video disc design and production process.

The next planning consideration relates to software design and development for this hardware system. This must be done before the unalterable video disc is created, since software is critical to ease of use of the final system. Software specifications are given later in this paper.

Planning must also consider new developments in technologies related to video discs. New developments in film, video, computer, and optical disc technologies are constantly appearing. For instance, erasable video discs are just becoming available. They would eliminate expensive mastering needed to replicate discs. Hybrid video discs are also being developed. They can store analog map and image frames plus digital data and software. New 16- and 32-bit microcomputers are becoming available which are more powerful than present 8- and 16-bit machines. Video disc software should be designed to be transferable to these new microcomputers. High definition television is also expected to become available in a few years. It offers over a thousand lines resolution, instead of the several hundred lines of present television. This will be of major importance to cartographic video discs.

Finally, planning must consider the time required to create an interactive video disc system. At least a full calendar year should be allotted for the entire design and production process.

GATHERING SOURCE MATERIALS

Sufficient time must be allowed for gathering necessary source materials to store on the disc. This can take six months or more. It is critical that a complete set of maps be obtained for a given geographic area. Generalized, small scale maps with large letters should be used to provide an overview of the area of interest. Consideration must also be given to obtaining aerial photographs, ground photographs, plus filmed aerial movies and video tapes. Organizational logos should also be included among these materials.

Source maps and images should be mosaicked prior to filming. This is necessary to achieve a sense of continuity when panning through the cartographic video disc data base. However, mosaicking must be done in a consistent manner. All source materials must be either on flat or rolled stock, not folded, and have more than one copy. These paper products must also be kept away from cold or dampness. During mosaicking, some sort of geometric control must be used, and the mosaicking errors kept to within specified limits. Once completed, the mosaics must be filmed as soon as possible, before dampness and temperature changes distort them.

The amount of control for mosaicking affects the final video map accuracy when used with geographic referencing software. Figure 3 shows a portion of two accurately mosaicked map edges. There is no noticeable mismatch between contour lines, streams, and roads running across the map edges. Figure 4 shows the intersection of four mosaicked map corners. Significant mismatch exists between features and grids on the map. In addition, the map in the upper right corner has a different style of design from the other three. Contour lines on this map portion are almost invisible, while the other three map edges have prominent contour lines. This underscores the need to obtain maps with consistent design and printing quality.

FILMING

In this phase, the source materials are photographed on 35-mm movie film. Several weeks should be allotted to do this task. For filming, a camera is mounted on a gantry and moved by computer control over the map or image mosaic. This same process could be done with a video camera and video tape, but film is less expensive than high quality video tape. Film also could be transferred to video tape for use with high definition television, when this becomes available.

It is critical that source material filming parameters be clearly specified. This is especially true when final video frames of maps and images must register exactly with each other. The photographer must know the following for every frame:

* Frame size
* Geographic coordinates
* Frame orientation
* Direction of filming
* Percent overlap

Frame size is of critical importance. For maps, a frame size must be selected so that all text and symbols on the map are readable on a television screen. This is approximately 2 by 3 inches (5 by 7 centimeters) on the map. Thus, an individual frame covers only a small portion of the map or image (Figures 3 through 6). Continuous tone images, such as aerial photographs, have less stringent frame size requirements. The best way to determine correct frame size is to view the paper cartographic product with a video camera and television monitor prior to filming.

If possible, frames should be centered on convenient geographic coordinates, either Universal Transverse Mercator (UTM) or Latitude-Longitude units, to allow for easier microcomputer control.

Frame orientation should always have geographic coordinate grid lines parallel to the television screen borders, with North at the top of the screen.

The direction of filming should not go across the source material in a serpentine manner. This causes problems when writing microcomputer software for the video disc. Instead, filming should be done in separate "horizontals" and "verticals." For curved grid lines, the camera must follow these curves to maintain a parallel grid from frame to frame.

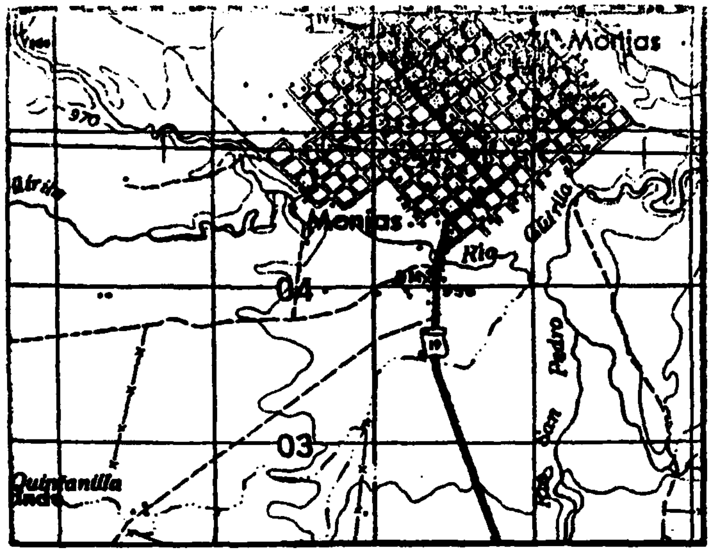


Figure 3 - Video disc map frame covering the edge of two mosaicked maps. Note no noticeable mosaic mismatch.

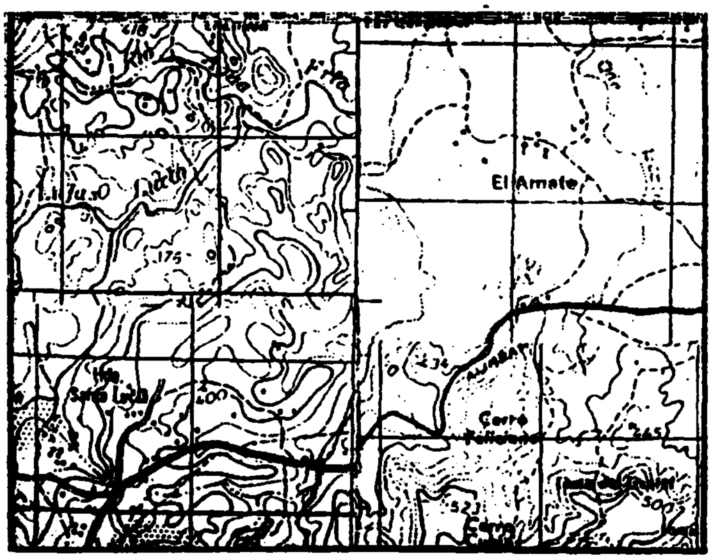


Figure 4 - Video disc map frame centered on intersection of four mosaicked map corners. Note mosaicking and map style mismatch.

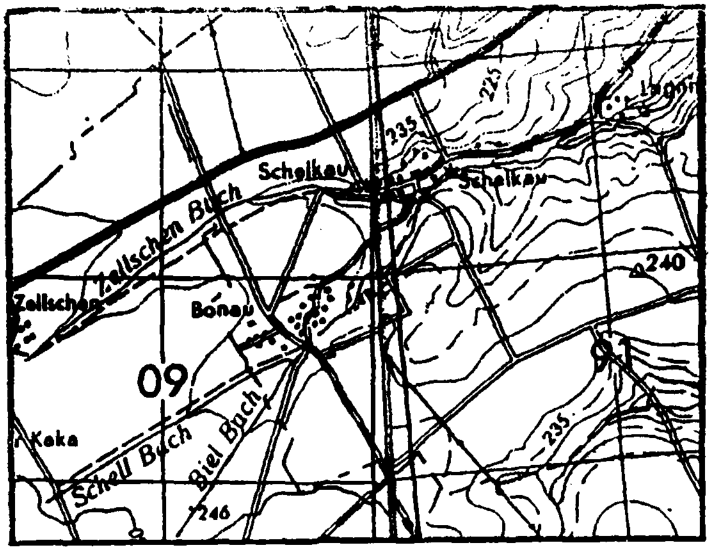


Figure 5 - Video disc map frame at edge of two mosaicked maps. Note different map grids.

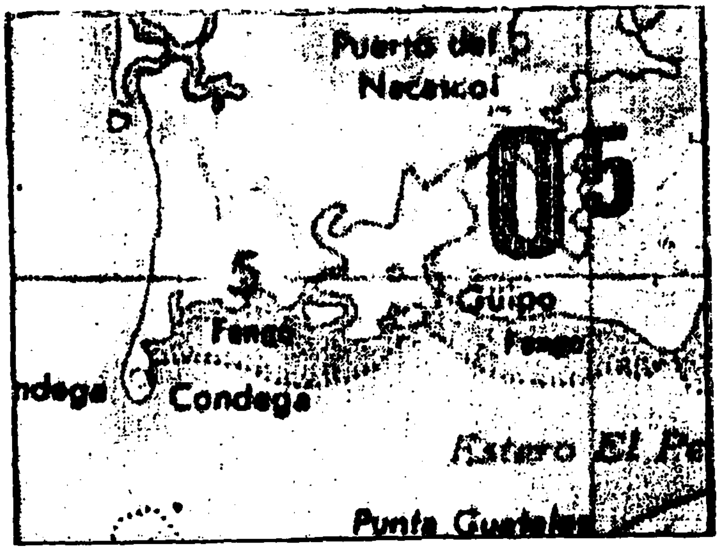


Figure 6 - Video disc map frame filmed out of focus.

Percent overlap should be given as a percentage of overlap between adjacent frames in both vertical and horizontal directions. Any value less than 75 percent results in a jumping, disorienting image motion as the user pans from frame to frame. However, less overlap allows for more frames to fit onto the disc.

Certain features on the source materials must be filmed separately. These include map legends and scales, which must be filmed so that as much information as possible appears on the screen at one time. This allows the user to read the information without losing it among poorly overlapped frames. Separate frames should also be filmed centered on specific areas of interest. These include point features: urban areas, high hills, and choke points as well as linear features: rivers, coastlines, and avenues of approach.

A major problem of filming is photographing edges of mosaicked products. Figure 3 shows the final video image of a carefully mosaicked and filmed map. All map features are readable, and all grid lines are parallel to the television screen. Figure 5, however, shows a similarly photographed frame that falls along the intersection of two different UTM grid zones. There is a significant difference in orientation of the grids, and not all grid lines are parallel to the television screen. Figure 6 shows a map frame filmed out of focus. These problems must be addressed in requirements and specifications for filming.

TRANSFERRING FILM TO VIDEO TAPE

At this stage, the film is transferred to a master video tape which is used to create the video disc master. The care taken to produce the film can be totally negated if improper transfer procedures are followed. The film must be transferred to the best quality video tape, i.e., 1-inch, type C. The final video frames must match the film parameters for 35-mm filming to avoid errors during the film-to-video transfer process. Color imbalances can also occur at this stage. Thus, it must be specified that color on the video picture must be corrected to match the color of the source material.

MASTERING

The master video tape is used to modulate a high-powered laser beam that burns pits and grooves into a photosensitive glass video disc master. This must be done in a clean laboratory setting, and not in the field. Only a few companies are capable of making glass video disc masters, so there can be delays of several weeks before these masters are created.

A plastic pre-production check video disc should be made before going into the replicating stage. This disc can be evaluated on a video disc player by checking for mapping data quality, completeness, and accuracy. Any problems can be noted and corrected on the master video tape before they show up in replicated copies. A new disc master is then generated from the corrected video tape.

REPLICATING

The glass video disc master is used to make duplicate plastic copies, in much the same way phonograph records are created. At this stage, it is important to specify how these discs are to be replicated. The most dimensionally stable replication technique is the "cold" method, which uses ultraviolet light to cure the plastic disc. Use of this technique should be specified.

Instructions for packaging and delivering the discs must also be specified. Stick-on labels with organization logos should be placed on each video disc and its disc album jacket to identify their contents. Duplicate copies of the video disc index must also be included with each disc. And finally, it should be specified that the plastic replicated discs be delivered, with all materials used to create the discs. These include:

* Source materials
* Original film
* Master video tape
* Glass video disc master

These materials are necessary for making additional copies of the disc.

DEVELOPING SOFTWARE

By itself, the video disc is only a collection of tens of thousands of individual television pictures. It becomes interactive when integrated into microcomputer systems controlled by extensive software. This software locates individual frames by finding their frame number on the video disc and then displaying that frame on the screen. This is basically where the role of the video disc ends and the role of the software begins. This software permits the user to work effectively with mapping data on the disc. With properly written software, the user could do the following:

* Zooming
* Panning or scrolling
* Geographic referencing
* Computer graphic symbol placement
* Video signal processing
* Multigraphic overlaying
* Frame fusing or mosaicking

Zooming allows the user to zoom in from a general view of an area to a more detailed view. The computer does this by pulling more detailed map and image frames from the video disc. The zoom effect is "jumpy" or "smooth" depending on the number of zoom levels recorded on the video disc.

Panning or scrolling lets the operator move around within each level of the data base. To do this, the computer rapidly displays consecutive frames from the video disc to give the illusion of motion. The effect will be "jumpy" or "smooth" depending on the amount of overlap between individual frames.

Geographic referencing allows a point on the video map or image to be selected, and its geographic coordinates calculated by the software. The accuracy of this feature depends on how well the map or image was mosaicked, filmed, and displayed.

Computer graphic symbol placement lets the operator draw from a software library of symbols and places them over the video map on the screen. Screen positions of these symbols could be stored and converted to geographic coordinates.

Video signal processing, multigraphic overlaying, and frame fusing or mosaicking options permit modifying the video picture itself. These options permit enhancement of map and image features, overlaying of separate frames on top of each other, and mosaicking of different frames simultaneously on the same screen, respectively.

The task of writing software is extremely labor intensive. At least three to six calendar months should be allotted to create, test, and debug software before the final system is ready for deployment. As mentioned earlier, most of the difficulty in creating this software can be avoided through initial planning. A software language should be chosen that is both easy to work with and transferable to different microcomputers. Creating the video disc in an organized fashion also saves time and effort during this development stage. Of critical importance is a complete index to the video disc. Filming parameters for every map and image frame must also be available. For greatest efficiency, these parameters should be placed in a computer readable format.

ETL VIDEO DISC RESEARCH

In 1982, the U.S. Army Engineer Topographic Laboratories (ETL) began studying mapping applications of video disc technology. To date it has obtained a standard institutional model video disc player interfaced to an 8-bit microcomputer (Figure 1). They are connected to a television monitor offering both touch screen control and computer graphic overlay capability. This equipment forms a testbed Map Video Processing (MVP) System.

In 1982 and 1983, ETL teamed up with three other government organizations to create an experimental cartographic video disc. These other organizations were the U.S. Army Corps of Engineers Water Resources Support Center, the U.S. Geological Survey National Cartographic Information Center, and the U.S. Navy Civil Engineering Research Laboratory. The disc was designed to contain a variety of mapping products. This video disc has been evaluated by ETL and is being used to demonstrate the possibilities of cartographic video disc systems.

ETL recently concluded a study into map graphic design for video discs. The study looked at the present state of the art in video disc research and development. It also investigated human factors related to perception and understanding of information derived from interactive video disc systems. This study demonstrated the need for requirements and specifications for putting mapping data on video discs. To fill this gap, ETL is developing such criteria and coordinating these with other government agencies. ETL will be performing another study to design special map graphics suitable for video display.

Lessons learned from this experimental video disc and graphic design study are being used by ETL to create a Fulda Gap Demonstrator video disc. This disc will contain paper maps, aerial photographs, satellite images, and weapons diagrams. This disc will demonstrate use of a cartographic video disc for tactical defense situations of the Fulda Gap, Germany.

ETL is also investigating future technologies important to cartographic video discs. ETL is creating an experimental hybrid video disc designed to contain both analog and digital mapping data. This will permit microcomputer access to several hundred megabytes of digital data, as well as analog images of standard maps. Another field being investigated is large screen displays and their applications to display maps from video discs. ETL has also acquired a microcomputer-controlled image digitizer for demonstrating video signal processing and multigraphic overlaying. All of this hardware will be integrated with the MVP system.

CONCLUSION

Video discs have tremendous potential for cartographic applications. Their capacity to hold maps, graphics, imagery, and even digital data solves many of the major problems of storage and access of large quantities of mapping products. These discs can be integrated into rugged, compact systems for almost any application, provided that rigid requirements and specifications are established for each phase of their design and production process.

END

FILMED

9-84

DTIC